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54 **Method and device for the determination of aerobic biodegradability.**

57 Method for the determination of the aerobic biodegradability in a composting device of at least one product, characterized in that an amount of the product is mixed with an amount of active inoculum and, if necessary, with an amount of water, such that the dry matter content of the mixture is situated between 40 and 60%, through at least one quantity of this mixture, that is maintained at a temperature of between 20 and 75 degrees Centigrade, gas containing oxygen is passed with a known CO₂ content that

is preferably zero, the amount of CO₂ coming from the mixture is accurately measured or calculated, an amount of inoculum alone is treated in just the same manner with the gas containing oxygen and also moreover the amount of CO₂ in the outflowing gas is measured, and finally on the basis of the amounts of CO₂ the amount of carbon is determined which originates from the product alone and is converted into CO₂ through biological activity.

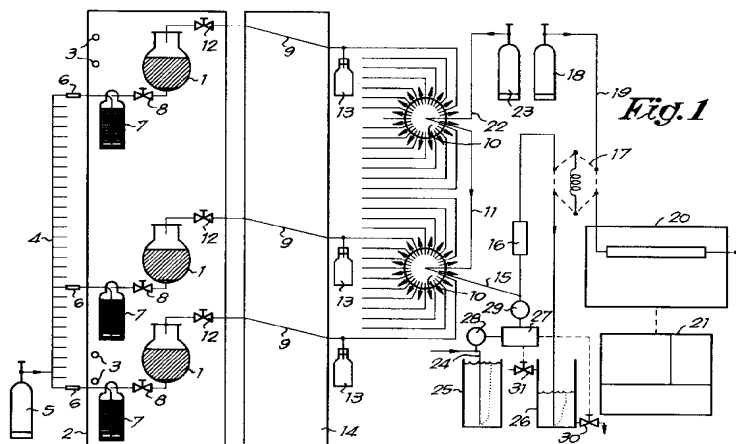


Fig. 1

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The invention relates to a method for the determination of the aerobic biodegradability in a composting device of at least one product.

Aerobic composting has already been utilized for a considerable time for biologically transforming organic waste products into a stabilized end product, namely compost. This composting is performed by aerating the organic waste products at a controlled degree of moisture. Bacteria and fungi transform the waste products into water, CO₂, and compost, whereby great quantities of heat are released. For household refuse the composting normally requires 8 to 20 weeks but for difficultly degradable substances the composting can require 1 to 2 years.

Because of the increasingly stringent environmental standards and the growing environmental awareness of consumers, many producers of all sorts of consumer goods, packaging materials, chemical products etc. are forced to make more environmentally friendly products. That is why it is necessary to be able to verify how these products, after use by the consumer, can be processed in the refuse chain. If the product is considerably biodegraded in a solid waste composting plant, this product is considered biodegradable or compostable.

Several methods are known for determining biodegradability. The known methods are especially directed towards determining the biodegradability of the products in a water treatment plant. Such a known method is the so-called STURM-test whereby the production of CO₂ by bacteria is measured in a wet environment. Since the microbiota, the temperature (10 to 20 degrees Centigrade) and other factors differ considerably in the wet conditions with less than 1% dry matter in a water treatment plant compared to these factors in the dry conditions with at least 30 to 40% dry matter and a temperature above 50 degrees Centigrade which are typical of a composting plant, this wet method is not suitable for determining the degradability in a composting plant. According to other known methods the product such as plastic of which the degradability has to be measured is, together with other material, placed in a composting vessel and after 6 to a weeks again removed and subjected to tests, such as the measurement of the tensile strength. These methods are indirect measurements and no proof is given that the product is actually degraded biologically.

The purpose of the invention is to provide a method for the determination of the aerobic biodegradability of at least one product under almost identical conditions to those in a real composting plant.

A further purpose of the invention is to provide a method whereby this determination is performed

under well defined and controlled conditions so that the results can provide statistical information of the degree and speed of the degradability of the product under specific composting conditions.

It is still further the purpose of the invention to have this determination take place under conditions which are optimum and accelerated and can be entirely controlled so that the method can be applied in different laboratories and reproducible information be obtained.

These objectives are achieved by making use of this invention according to which a well defined amount of the product is mixed with an amount of active inoculum and, if necessary, an amount of water, such that the dry matter content of the mixture is situated between 40 and 60%, and that through at least one quantity of this mixture, that is maintained at a constant temperature of between 30 and 75 degrees Centigrade, gas containing oxygen is passed with a known CO₂ content that is preferably zero, the amount of CO₂ coming from the mixture is accurately measured or calculated, an amount of inoculum alone is treated in just the same manner with the gas containing oxygen and also moreover the amount of CO₂ in the outflowing gas is measured, and finally on the basis of the amounts of CO₂ the amount of carbon is determined which originates from the product alone and is converted into CO₂ through biological activity.

The determination of the aerobic degradability is effected under the conditions of a controlled and optimum composting.

As gas containing oxygen, air, preferably CO₂-free air, or pure oxygen can be used.

In a particular embodiment of the invention the same amount of inoculum alone is used as the amount of inoculum in the mixture and the amount of converted carbon coming from the increased production of CO₂ by the mixture is determined.

In a notable embodiment of the invention the gas containing oxygen is passed through a reactor with a volume of between 1 and 10 liters of the mixture product-inoculum.

In a suitable embodiment of the invention 5 to 50% product is mixed with 95 to 50% inoculum in order to form the mixture.

The carbon content of the original product is preferably determined separately.

The amount of CO₂ produced can be measured by absorption in Ba(OH)₂ or by measuring the incoming and outflowing gas flow for at least a specific time and measuring the CO₂ content thereof.

The invention also relates to a device which is particularly suitable for the application of the method according to one of the preceding embodiments.

The invention especially relates to a device for

the determination of the aerobic biodegradability in a composting device of at least one product, characterized in that it comprises at least two reactors, means for maintaining these reactors at a temperature above the ambient temperature, means for passing gas containing oxygen through the reactors, means for separately collecting the outflowing gas from each reactor and means for measuring or calculating the amount of CO₂ in this gas.

The device preferably comprises means for calculating the amount of carbon which is degraded based on these amounts of CO₂ flowing out of the reactors.

In order to show better the characteristics according to the present invention, some preferred embodiments of a method and device for the determination of aerobic biodegradability according to the invention are described hereafter, as examples and without any restrictive character with reference to the enclosed drawings in which:

Figure 1 shows schematically a device for the determination of the biodegradability of products according to the invention;

Figure 2 shows a graph of the CO₂ production in function of time, during the application of the method according to the invention;

Figure 3 shows the percentage of carbon that was converted from a product in function of time during the application of this method.

In order to determine simultaneously the aerobic biodegradability of a number of products, use is made of the device shown in figure 1.

This device comprises several closed reactors 1, for example 30, of which for the sake of simplicity only three are drawn in figure 1, which are disposed in a thermally insulated incubator 2 which is maintained at a specific temperature by means of heating elements 3.

An air supply pipe 4 connects to the underside of each reactor 1. All the air supply pipes 4 are connected to the same tank 5 with dry air under pressure which is free of CO₂. In each air supply pipe 4 between the tank 5 and the reactor 1 is successively mounted a flow rate meter 6 with regulator, a bubbler 7 filled with water in order to reach 100% humidity and to maintain the desired dry matter content, for example of 50% in the reactor 1, and a closing valve 8. The bubbler 7 and the closing valve 8 are in the incubator 2. On the upper side of each reactor 1 a gas outflow pipe 9 is mounted which is connected to a multi-port valve 10. The multi-port valve has different inlets which are each connected by an individual outlet and one common outlet. For thirty possible reactors 1 the device comprises two such valves 10 since each valve only has sixteen inlets. One outlet of one valve 10 is connected by a pipe 11 to an inlet of the other valve 10.

Inside the incubator 2 a cut off valve 12 is mounted in each gas outflow pipe 6. Outside the incubator 2 each outflow pipe 9 connects to a condensation flask 13 for the collection of the condensed water. Between the cut off valve 12 and the condensation flask 13 the gas outflow pipes 9 extend through a common cooling unit 14. The cut off valves 8 and 12 are detachable from the pipes 4 or 9 and allow both the air supply and the gas outflow to be closed and the reactor 1 to be removed from the incubator 2 in its entirety for shaking and weighing this reactor.

On a regular basis, for example every three or four hours each of the multi-port valves 10 connects a specific outflow pipe 9, possibly through the pipe 11 and the other valve 10, to a pipe 15 which connects to one outflow of a valve 10. The other outflow pipes 9 are then connected to the other outflows of the two valves 10 which themselves are connected through a pipe 24 to an open bubbler 25. In the pipe 15 which also exits on a bubbler 26 is mounted an accurate flow rate meter 16. By means of a sampling loop 17 the gas in the pipe 15 is sampled. Through this loop 17 a sample is taken along by carrier gas that is passed out of the tank 18 through the pipe 19 continually to the gas chromatograph 20 where the sample can be analyzed. The measurement results are transmitted to the data processor 21 with printer thereto connected.

From time to time, for example every three to four hours one of the valves 10 connects one outlet which connects to the pipe 15 to one inlet which itself is connected through pipe 22 to a tank 23 in which there is a gas mixture of which the composition is accurately known.

Of the products of which the aerobic degradability must be determined, first specific, preferably equal amounts are weighed out, whereby three identical amounts of each product are weighed out. Of each product the exact amount of carbon is determined according to known ways, for example according to the international standard ISO 625-1975 (F). Each of the amounts of product is subsequently mixed very thoroughly with inoculum, preferably originating from the organic fraction of household refuse, in a ratio of at least 5 to 50 weight percent product in 100% mixture. The mixture preferably comprises at least five times more inoculum than product.

The inoculum originates from the organic fraction of household refuse. This inoculum can be added fresh or an inoculum can be added that was previously composted for a certain time, namely for 2 to 4 months, preferably in the laboratory under controlled and optimum conditions. A fresh inoculum will give results which resemble more closely the real situation in a composting plant,

while inoculum that was previously composted, will show less background production of CO₂ and the results will be clearer and more accurate. The inoculum preferably has such an activity that it produces between 10 and 150 mg CO₂ per gram volatile solid material for the first ten days and preferably has an ash content lower than 70% on dry weight. The inoculum is preferably free of large inert parts such as glass, metal etc. and sieved so that the particles are smaller than 25 mm, preferably smaller than 5 mm.

If necessary the solid substance content of the various mixtures of inoculum-product is corrected by the addition of water, to 40 to 60% and preferably 45 to 55% and for example 50% and these mixtures are subsequently separately placed in the reactors 1. From each product therefore three reactors have been filled with the same mixture. Three reactors 1 are however not filled with a mixture but with inoculum only and then preferably with an amount of inoculum which is equal to the amount of inoculum in the mixtures in each of the other reactors. In order to avoid overheating and to obtain the correct temperature in the reactors 1, the volume of the mixtures in the reactors 1 is situated between 1 and 10 liters. As reference for one of the products a material can be used of which the aerobic degradability is known, such as cellulose for example.

During determination with the assistance of the heating elements 3 which have been arranged in the incubator 2 as shown in figure 1, the temperature in the reactors 1 is maintained as constant as possible at a value between 20 and 75 degrees Centigrade and preferably at 50 degrees Centigrade. Temperature deviations are limited to 2 degrees. One can also follow a predetermined temperature profile which more accurately resembles the temperature encountered in full scale composting plants for refuse. One can, in a first phase, operate for example for 2 days at a temperature of 35° C, followed by a period of 5 days or so at a temperature of circa 58° C and subsequently back down to a temperature of 50° C. After a period of around 20 to 40 days or more of composting at 50° C, one can choose to simulate a maturation phase and operate the composting vessels at mesophilic (30 to 40° C) or at room - or ground temperatures (5 to 20° C).

For a period of 10 to 70 and preferably 45 to 60 days but possibly longer if necessary, a well defined flow of CO₂-free air is allowed to flow from the tank 5 through the bubbler 7 where the air is humidified, into the reactor 1 and therefore through the material installed therein. The flow that passes through the reactors 1 must be sufficiently large in order to ensure that the oxygen in the gases flowing out of the reactor is not entirely used up and

that preferably the oxygen content does not descend below 6% and preferably not under 8%. This flow is established by means of the flow rate meters 6 with regulators.

In another variation pure oxygen can be added in place of air in which case the flow rate can be less.

Because of the fact that the bubblers 5, in which the added air is humidified is at the same temperature as the reactors 1 condensation in these reactors 1 is avoided. The bacteria and fungi can under optimum conditions in warm and sufficiently humid conditions bring about biodegradation in the reactors 1 and convert the carbon in the material into CO₂.

The gases which are removed separately from the reactors 1 through the gas outflow pipes 9 are cooled in the cooling unit 14 first down to a temperature lower than 4 degrees Centigrade. Subsequently they are sent to the multi-port 10. Of all the gas flows, of which the multi-port valves 10 successively send an amount to the flow rate meter 16, the flow is very accurately determined with this flow rate meter at regular time intervals so that from there the development of the gases flowing out of the reactors 1 can be deduced in function of time.

In order to measure accurately the flow that effectively goes through the reactors 1 and the whole device, with the transfer from one reactor 1 to another reactor 1, for the first two to three minutes, the pressure in the pipe 15 is made equal to the pressure in the common pipe 24. Use is hereby made of a pressure regulator 27 which is connected to two pressure sensors 28 and 29, respectively to the pipe 24 and the pipe 15. The overpressure by the water in the bubbler 25 is so adjusted that it is always higher than the pressure over the flow rate meter 16.

With the transfer from one reactor 1 to another reactor 1, another pressure will build up in the pipe 15 in function of among others the flow rate that is adjusted in the flow rate regulator of the flow rate meter 6 for that specific reactor 1. This pressure is observed by the pressure sensor 29 and transmitted to the pressure regulator 27 which is connected to the pressure sensor 28. If the pressure in the pressure sensor 29 becomes higher than the pressure in the pressure sensor 28, then the pressure regulator 27 will open the valve 30, through which water from the bubbler 26 flows outward and the overpressure on the pipe 15 decreases until the pressure in the pipe 15 is equal to the pressure in the pipe 24. If, when transferring to a new reactor 1 to be sampled, the pressure in the pipe 15 decreases and becomes less than the pressure in the pipe 24, then the pressure regulator 27 opens the valve 31, through which water is supplied to the

bubbler 26, until the two pressure sensors 28 and 29 measure the same pressure in the pipes 24 and 15.

Only when this is reached is the flow rate in the pipe 15 accurately measured by the flow rate meter 16 and signalled through to the data processor 21 as correct flow rate. After the measurement of the flow rate, after approximately 3 minutes after the transfer, for about thirty seconds the gas in the pipe 15 is sampled via the sampling loop 17 and a gas sample with carrier gas is taken out of the tank 18 through the pipe 19 to the gas chromatograph 20.

In this manner both an exact determination of the flow rate that goes through the reactor 1 and the composition of the gas that comes from the same reactor is obtained.

The amount of CO₂ produced is calculated on the basis of the flow rate and the CO₂ content that is measured with the gas chromatograph 20. Of course an average is made from the three amounts of a same mixture in a group of three reactor 1. Because of the fact that three reactors 1 are filled with inoculum only it is possible to calculate in the same manner the amount of CO₂ originating from the inoculum in a specific mixture. The increased production of CO₂ by this mixture consequently originates from the product in the mixture.

Before the amounts of gas are used for the calculation, the measured or calculated volumes are reduced to volumes at standard temperature and pressure.

The percentage of biodegradability is calculated by the net amount of gaseous carbon produced by a product that is part of a specific mixture divided by the amount of solid carbon which was originally present in this same product, and multiplied by one hundred.

In a variation of the above described method the amounts of CO₂ produced are not calculated on the basis of flow rate measurements but by collecting and absorbing the gases originating from the reactors 1 in Ba(OH)₂. When this substance reacts with CO₂, it forms an insoluble precipitation of barium carbonate. Through titration with for example HCL the amount of remaining barium hydroxide can be determined. The number of moles of CO₂ absorbed can then be calculated as : $\text{mol CO}_2 = \text{mol Ba(OH)}_2 \text{ at the start} - 0.5(\text{mol HCl})$.

The amount of CO₂ produced from a product in a reactor 1 can be determined by the difference in ml of the HCl used for the titration of Ba(OH)₂ with all gas collected from a reactor with a specific mixture and of the HCl used for the titration of Ba(OH)₂ with all gas collected from a reactor with only inoculum multiplied by the normality of the HCl used and the molecular weight of CO₂ and divided by 2.

In another variation the amount of CO₂ can also be determined by a combination of flow rate measurement and CO₂ concentration measurement by means of other analytical systems (e.g. CO₂ analysis based on infrared measurement).

In another variation not only the biodegradation is determined based on carbon conversion, calculated out of net CO₂ production on the basis of CO₂ measurement, but also oxygen consumption is determined. For this purpose a unit as represented in figure 1 can be used. When analyzing the gas coming from a reactor 1, not only the concentration of CO₂ is determined but also that of O₂. In combination with the flow rate and after correction to standard conditions of temperature and pressure the exact oxygen consumption can be calculated. By subtracting the oxygen consumption of the inoculum only, the net oxygen consumption originating from the test material can be calculated. Furthermore, also the respiration coefficient can be calculated by dividing the net CO₂ production by the net O₂ consumption. Both parameters, O₂ consumption and respiration coefficient, give additional information with regard to the biological degradability of a test material.

The invention will be specified in greater detail by the following concrete example.

EXAMPLE.

As product of which the aerobic degradability has been determined, microcrystalline cellulose powder for thin layer chromatography has been utilized. Cellulose is generally known as a product that degrades completely but of which the biodegradation starts relatively slowly.

The organic fraction of mixed household refuse has been used as inoculum which was composted for eight weeks in the laboratory in order to obtain as low a background activity as possible. The dry matter of the inoculum amounted to 49.2%.

Three reactors (flasks of 4 l) have been filled with 1100 g inoculum. Three other reactors have been filled with a mixture of 1100 g inoculum and 140 g cellulose powder and 86 g water in order to obtain a solid dry matter content of between 40 and 60%. The six reactors have been mounted in a device as shown in figure 1. The heating of the incubator 2 was started and the reactors were incubated for 60 days in the dark at a temperature of 50 degrees Centigrade.

Such an air flow has been passed through the reactors 1 that the oxygen content in the outflowing gases from the reactors amounted to at least 6%.

The CO₂ production was determined on the basis of measurements of the gas flow and the CO₂ concentration every three hours. The evolution of the cumulative CO₂ production in grams in func-

tion of time in days is shown in figure 2 respectively for the inoculum only (the lower three lines) and for the mixture of inoculum-cellulose (the upper three lines). After sixty days the cumulative CO₂ production for the inoculum amounted respectively to 135.9; 125.7 and 123.4 grams and for the mixture respectively to 307.6; 286.4 and 302.2 grams. After calculation the average net CO₂ production per unit weight of cellulose can be obtained. After sixty days this amounted to 1204 mg per gram cellulose. From this the average amount of carbon in the form of gas could be calculated while the original amount of carbon in the cellulose was also calculated through the carbon content (39.7%) of the cellulose used and the amount of cellulose in a mixture. Finally it was possible to calculate the conversion percentage of solid carbon in the cellulose into gaseous carbon in this manner. The graphic evolution of this percentage in function of time in days is shown in figure 3. The major part of the conversion took place in the first 30 days of the incubation. After 60 days the conversion of solid carbon originating from the cellulose into gaseous carbon amounted to 83%.

The above described method is very simple and accurate and offers reliable and reproducible results.

The present invention is in no way restricted to the embodiments described above and these embodiments can be implemented with many changes without departing from the scope of the present invention application.

In particular it is not necessary to treat three amounts of inoculum and three amounts of mixture inoculum-product as described above. One amount is in fact sufficient, but several amounts obviously offer a greater accuracy.

Claims

1. Method for the determination of the aerobic biodegradability in a composting device of at least one product, characterized in that an amount of the product is mixed with an amount of active inoculum and, if necessary, with an amount of water, such that the dry matter content of the mixture is situated between 40 and 60%, and through at least one quantity of this mixture, that is maintained at a temperature of between 30 and 75 degrees Centigrade, gas which contains oxygen is passed with a known CO₂ content that is preferably zero, the amount of CO₂ in the gas coming from the mixture is accurately measured or calculated, an amount of inoculum only is treated in just the same way with the gas containing oxygen and also moreover the amount of CO₂ in the outflowing gas is measured, and finally on the

basis of the amounts of CO₂ the amount of carbon is determined which originates from the product alone and is converted into CO₂ through biological activity.

2. Method according to the preceding claim, characterized in that air is used as gas which contains oxygen.
3. Method according to the preceding claim, characterized in that CO₂-free air is used as gas which contains oxygen.
4. Method according to claim 1, characterized in that pure oxygen is used as gas which contains oxygen.
5. Method according to any one of the preceding claims, characterized in that the gas which contains oxygen is humidified prior to using it.
6. Method according to any one of the preceding claims, characterized in that the same amount of inoculum only is used as the amount of inoculum in the mixture and the amount of converted carbon is determined departing from the increased production of CO₂ by the mixture.
7. Method according to any one of the preceding claims, characterized in that the gas containing oxygen is passed through a reactor with a volume of between 1 and 10 liters of the mixture product-inoculum.
8. Method according to any one of the preceding claims, characterized in that 5 to 50% product is mixed with 95 to 50% inoculum in order to form the mixture.
9. Method according to any one of the preceding claims, characterized in that five times more inoculum than product is put in the mixture.
10. Method according to any one of the preceding claims, characterized in that the carbon content of the original product itself is determined.
11. Method according to any one of the preceding claims, characterized in that the amount of CO₂ gas produced is measured by absorption in Ba(OH)₂.
12. Method according to any one of the claims 1 to 10, characterized in that the amount of CO₂ gas produced is calculated out of the flow rate of outflowing gas and the CO₂ content thereof that is measured.

13. Method according to any one of the preceding claims, characterized in that the dry matter content of the mixture is brought to 45 to 55% prior to passing the gas which contains oxygen through it. 5
14. Method according to any one of the preceding claims, characterized in that during the through flow of the gas which contains oxygen the temperature in the mixture is maintained at 50 degrees with a tolerance of 2 degrees Centigrade. 10
15. Method according to any one of the preceding claims, characterized in that a gas which contains oxygen is passed through the mixture for 20 to 70 days. 15
16. Method according to any one of the preceding claims, characterized in that the gas containing oxygen is passed through the mixture with such flow rate that the amount of oxygen in the outflowing gas is higher than 6%. 20
17. Method according to any one of the preceding claims, characterized in that of the mixture inoculum-product and of inoculum only each time at least two amounts are treated and for the calculation of the degradability use is made of the averages of the amounts of CO₂ produced by the amounts of inoculum and the averages of the amounts of CO₂ produced by the amounts of mixture. 25 30
18. Method according to any one of the preceding claims, characterized in that the outflowing gas is first cooled prior to determining the CO₂ content thereof. 35
19. Method according to the preceding claim, characterized in that the outflowing gas is cooled down to a temperature lower than 4 degrees Centigrade. 40
20. Method according to claim 12, characterized in that the treatments with a gas which contains oxygen are performed in reactors (1), the outflowing gases from all these reactors (1) are passed through at least one multi-port valve (10) to a common pipe (15), in which a flow rate meter is mounted, the pressure difference between the outlet of the distribution valve (10) to which the pipe (15) is connected and the outlet of this pipe (15) situated downstream from the flow rate meter (16) is compensated and the flow rate is only read from the flow rate meter (16) when the extra overpressure created from the distribution valve (10) to the outlet of the pipe (15) is the same pressure as the pressure in the reactors (1) themselves for the time that they are not connected to the pipe (15). 45 50 55
21. Method according to the preceding claim, characterized in that the aforementioned pressure difference is compensated by counter-pressure valves or bubblers (25 and 26) with water.
22. Method according to any of the preceding claims, characterized in that the oxygen consumption is also determined.
23. Device for the determination of the aerobic biodegradability in a composting device of at least one product, characterized in that it comprises at least two reactors (1), means (2, 3) for maintaining these reactors (1) at a temperature above the ambient temperature, means (5, 4) for passing gas which contains oxygen through the reactors (1), means (9, 10, 15) for separately collecting the outflowing gas from each reactor and means (16, 20) for measuring or calculating the amount of CO₂ in this gas.
24. Device according to the preceding claim, characterized in that it comprises means for calculating the amount of carbon which was degraded starting with the amounts of CO₂.
25. Device according to one of the claims 23 and 24, characterized in that the means for measuring or calculating the amount of CO₂ comprise a flow rate meter (16).
26. Device according to the preceding claim, characterized in that it comprises several reactors (1), at least one multi-port valve (10), gas outflow pipes (9) which connect the various reactors (1) separately to inlets of the distribution valve (10), a common pipe (15) which connects to one outlet of the distribution valve (10) and in which the flow rate meter is mounted, a pipe (24) which is connected to the other outlets of the distribution valve (10) and therefore to the reactors (1) when they are not connected to the aforementioned common pipe (15), and means (25 to 31) for compensating the pressure difference between the pressures in the latter two pipes (15 and 24).
27. Device according to the preceding claim, characterized in that the means (25 to 31) for compensating the pressure difference comprise a bubbler (26) in which the outlet of the common pipe (15) exits, a water supply pipe

with a controlled valve (31) which exits in the bubbler (26), a water drainage pipe with a controlled valve (30) which connects to the bubbler (36), a second bubbler (25) in which the other pipe (24) exits, a pressure regulator (27) which operates the aforementioned valves (30 and 31) and two pressure sensors (28 and 29) which respectively measure the pressure in the two aforementioned pipes (15 and 24) and transmit this information to the pressure regulator (27).

28. Device according to any one of the claims 23 to 27 characterized in that it comprises means to measure or to calculate the amount of oxygen which has been consumed.
29. Device according to any one of the claims 23 to 27 characterized in that the CO₂ concentration in the gas flow is determined in another way than through gas chromatography (e.g. with CO₂ analysis through infrared measurement).

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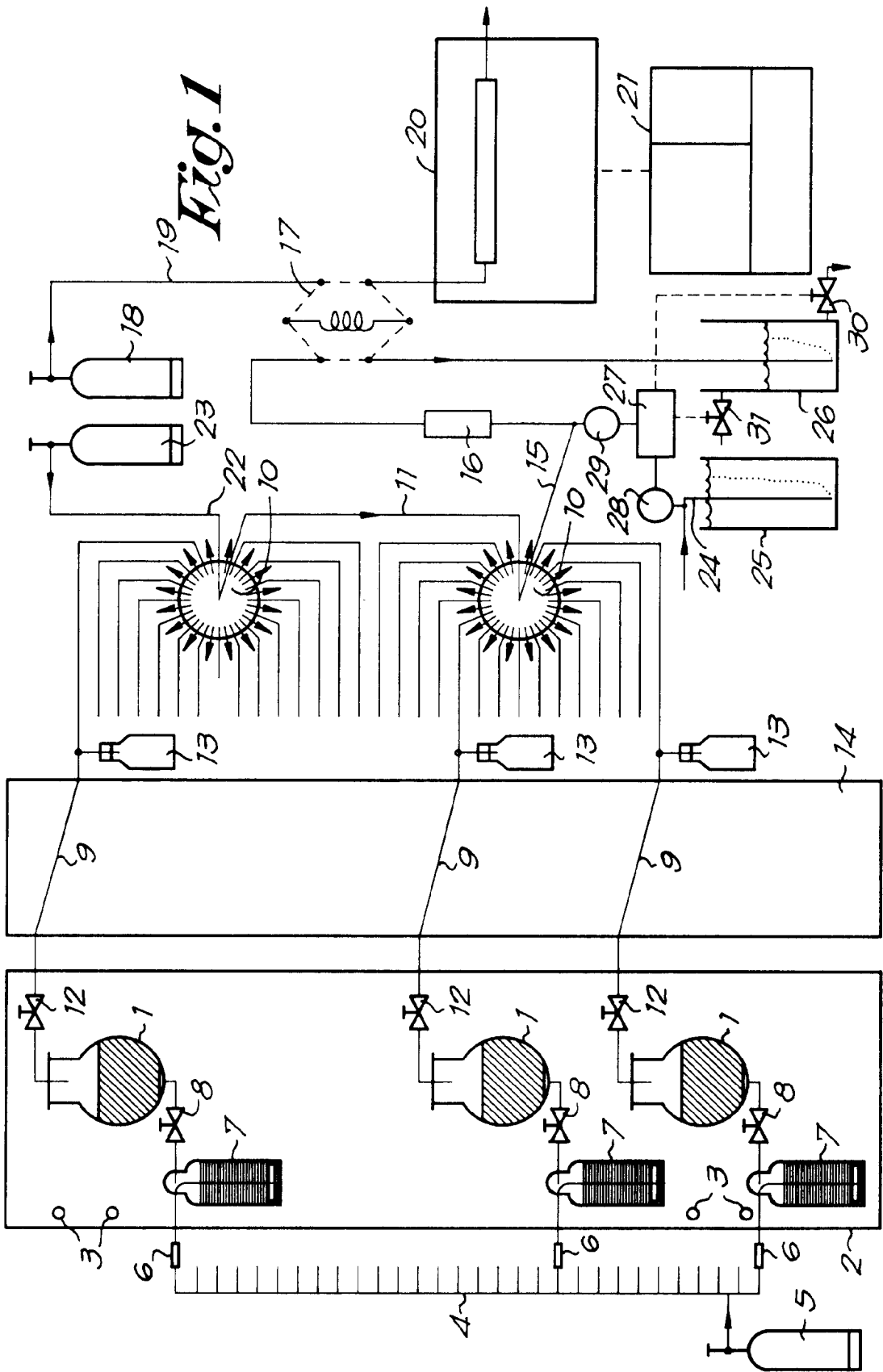
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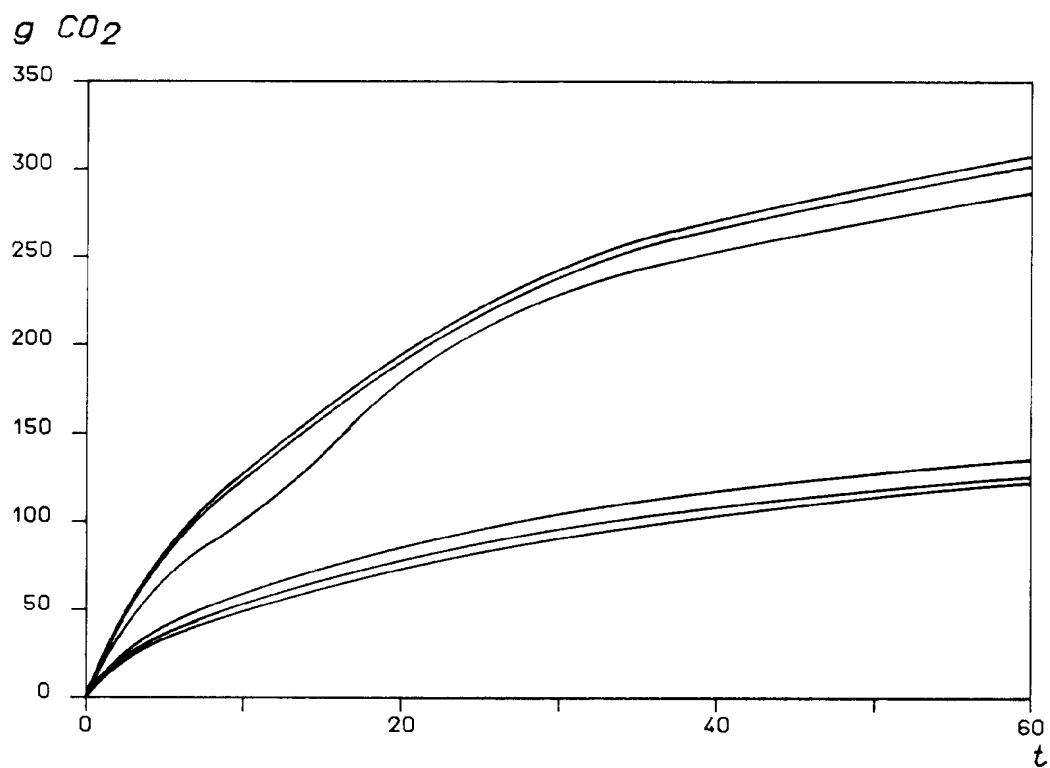
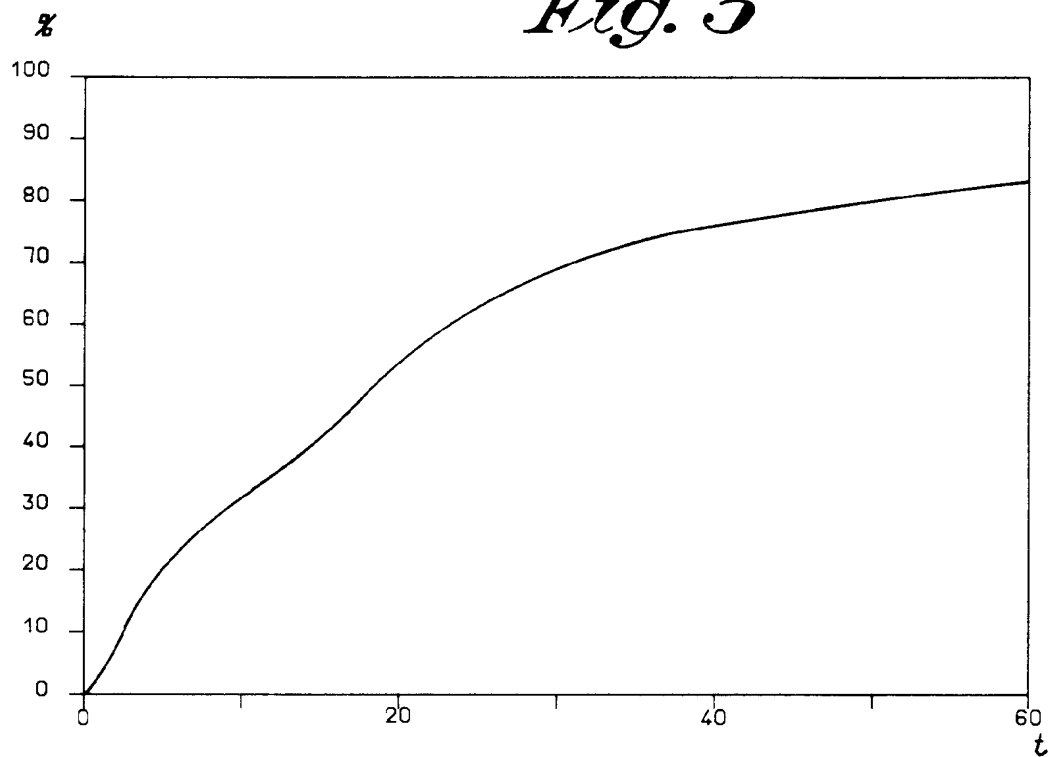


Fig. 2

Fig. 3





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number

EP 92 20 0196

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
Y	US-A-4 062 770 (F.X. KNEER) * the whole document * ---	1-29	C12Q1/02 C02F3/02 C12M1/04
Y	SU-A-517 845 (WATER SUPPLY HYDROGEOLOG) *see abstract* ---	1-29	C12M1/34 C12M1/00 C05F17/00
Y	APPLIED AND ENVIRONMENTAL MICROBIOLOGY vol. 49, no. 1, January 1985, WASHINGTON DC USA pages 37 - 41; K. NAKASAKI ET AL.: 'Change in microbial numbers during thermophilic composting of sewage sludge with reference to CO2 evolution rate.' * the whole document * ---	1-29	C05F17/02 C05F9/04
A	PATENT ABSTRACTS OF JAPAN vol. 6, no. 265 (P-165)(1143) 24 December 1982 & JP-A-57 158 558 (NIPPON KOKAN) 30 September 1982 * abstract * -----	1-29	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			C12Q C02F C12M C05F
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 21 MAY 1992	Examiner VAN BOHEMEN C. G.
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ----- & : member of the same patent family, corresponding document	